Considerations for Zinc and Manganese

Results of the SLERA indicate there is a low potential for risk to soil invertebrates and plants from zinc and manganese concentrations, based on a simple screen against EPA's ecological soil screening levels (EcoSSLs). Specifically, exposure point concentrations (EPCs) based on 95UCLs for zinc in the Process Areas exceed EcoSSLs for soil invertebrates and plants. Similarly, EPCs for manganese in the Loading Dock Area and Tank Farms exceed EcoSSLs for plants[1]. The following table summarizes the EPCs and resulting hazard quotients (HQs):

COPC	EPC (95UCL) mg/kg	Plant EcoSSL mg/kg	Plant HQ	Invert EcoSSL mg/kg	Invert HQ
Process Areas					
Zinc	470	160	**3**	120	**4**
Loading Dock Area and Tank Farms					
Manganese	403	220	**2**	450	<1

The SLERA showed that HQs for plants and soil invertebrates from potential zinc and manganese impacts are low, ranging from 2 to 4. Some locations with elevated concentrations that are driving the EPCs are co-located with high concentrations of lead and/or benzo(a)pyrene that are targeted for removal, particularly in the Process Areas **(Figure 1**). Therefore, post-removal concentrations of zinc across the Process Areas will be lower, reducing the HQs even further.

Scattered elevated concentrations of manganese are located in the North Tank Farm in areas of re-worked soil and sand along the gas pipeline that are used for storage of various materials (**Figure 2**). These areas have been cleared of vegetation and are continuously used for industrial purposes. As such, they lack sufficient quality habitat for ecological receptors. Sporadic elevated concentrations of manganese also occurring in the East Tank Farm are likely anomalies and not linked to any recent or historical on-site activities (**Figure 3**). These areas are also void of vegetative cover due to the industrial use as a tank farm and therefore provide insufficient habitat for ecological receptors. Test-pitting conducted in the vicinity of elevated metals concentrations at the Tank Farms did not indicate any major waste items or residual process materials that could be linked to zinc or manganese.

There is a lack of general toxicity from zinc and manganese, both of which are essential elements for all living organisms and are naturally occurring, sometimes at high concentrations. Thus, there is unlikely to be adverse effects on soil invertebrates or plants. Elevated concentrations of these metals on site are sporadic and unlikely to impact entire populations. In addition, aging/weathering reduces the bioavailable fraction of metals in soil over time (EPA 2007a). Processing activities ended in the 1960s, thus much of the metallic residues are likely tightly bound to soils due to weathering, aging, and other natural processes. No instances of plant toxicity have been observed on site. Both metals, in their bioavailable forms, are easily taken up by soil invertebrates, particularly earthworms, which are capable

[1] It should also be noted that many of the concentrations of zinc and manganese are J-qualified which indicates some uncertainty in the data and the reported results that cannot be quantified.

of regulating uptake and storage of metals. In fact, uptake by soil invertebrates is nonlinear and decreases as soil concentration increases (EPA 2007a).

Manganese is essential in plant nutrition for the oxidation-reduction process during photosynthesis. In its soluble form, manganese is taken up by plants and rapidly distributed throughout the plant. Manganese toxicity in plants is demonstrated by iron chlorosis, leaf puckering, necrotic brown spots, and an uneven distribution of chlorophyll in older leaves (EPA 2007b). Toxicity data used to develop EPA's EcoSSL for plants indicates some plants (e.g., cotton and nile grass) did not show adverse impacts to growth until manganese concentrations in the soil reached 707 mg/kg (EPA 2007b).

Zinc is expected to demonstrate low mobility in most soils and is strongly adsorbed to soils at pH 5 or greater (EPA 2007c). Only those fractions of zinc in soil which are soluble or may be solubilized are bioavailable. Compared to total zinc content of soils, concentrations of zinc in soil solution are low. The solubility of zinc increases at decreasing pH (EPA 2007c). The pH at the site, particularly in the Wilcox Process area, is neutral to basic with an average pH of around 8. The Lorraine Process Area contains slightly more acidic soils with an average pH of around 6. The pH in both these areas is not low enough to mobilize zinc and increase its bioavailability. A search of EPA's Ecotox database indicates zinc toxicity to invertebrates varies greatly, depending on form, soil type, species, pH, organic content, and exposure time. Effects concentrations range from 1.5 to 5150 mg/kg in springtail, with an average of 806 mg/kg.

In plants, zinc is necessary for carbohydrate and protein metabolism. Excess zinc produces iron chlorosis (EPA 2007c). EPA's Ecotox database indicates zinc toxicity to plants varies greatly, with effects values ranging from 5 mg/kg in brown mustard (*Brassica juncea*) to 1000 mg/kg in field mustard (*Brassica rapa*), with an average of 425 mg/kg. Thus, the EcoSSLs for zinc of 120 mg/kg for plants and 160 mg/kg for soil invertebrates are highly conservative and should only be used for original intended purpose —to screen the data as they are too conservative to be used as cleanup goals.

In summary, there is unlikely to be adverse impacts to the plant or soil invertebrate communities at the site from either zinc or manganese concentrations based on the following:

- Low HQs identified in the SLERA, based solely on a screen against EcoSSLs.
- Low potential for uptake and toxicity from these essential, naturally occurring metals.
- Sporadic elevated concentrations not causally linked to facility activities.
- Lack of sufficient ecological habitat from long-term industrial usage of many portions of the site.
- Removal of select concentrations of zinc during excavations for lead and/or benzo(a)pyrene, thus reducing the overall HQs for zinc.

References

EPA 2007a. *Framework for Metals Risk Assessment*. Office of the Science Advisor Risk Assessment Forum EPA 120/R-07/001. March.

EPA 2007b. *Ecological Soil Screening Levels for Manganese*. Interim Final OSWER Directive 9285.7-71. April.

EPA 2007c. *Ecological Soil Screening Levels for Zinc*. Interim Final OSWER Directive 9285.7-73. June.